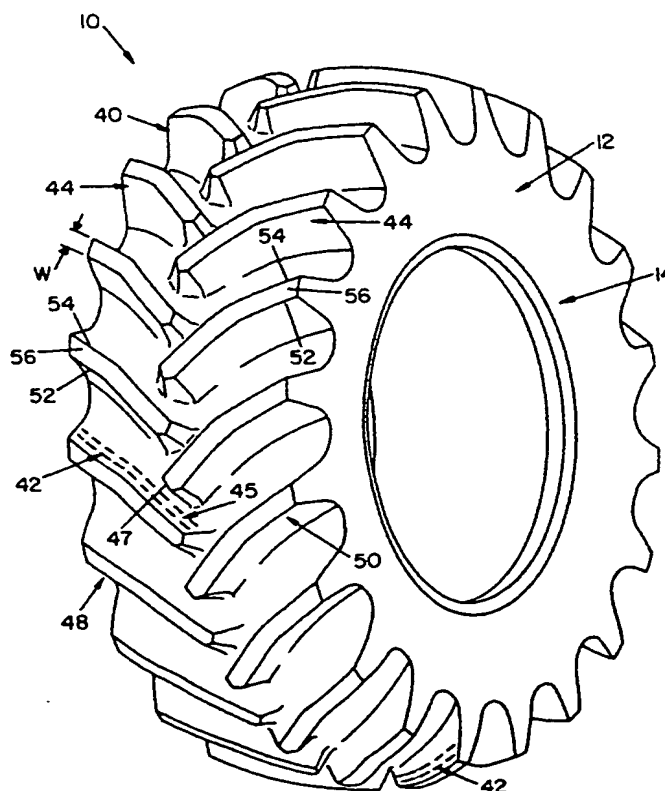


## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>7</sup> :</b> <b>B60C 11/24, 11/04 // 107:02</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 00/66372</b> <b>(43) International Publication Date:</b> 9 November 2000 (09.11.00)
<b>(21) International Application Number:</b> PCT/US99/09394 <b>(22) International Filing Date:</b> 30 April 1999 (30.04.99) <b>(71) Applicant (for all designated States except US):</b> THE GOODYEAR TIRE & RUBBER COMPANY [US/US]; D/823, 1144 East Market Street, Akron, OH 44316-0001 (US). <b>(72) Inventors; and</b> <b>(75) Inventors/Applicants (for US only):</b> KORNELIS, Hendrik [LU/LU]; Seiteschgrund, L-9281 Diekirch (LU). GUILLAUME, Pascal [BE/BE]; 59 Neffe, B-6600 Bastogne (BE). <b>(74) Agent:</b> WHEELER, David, E.; The Goodyear Tire & Rubber Company, 1144 East Market Street, Akron, OH 44316-0001 (US).		<b>(81) Designated States:</b> AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW. ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>With international search report.</i>

**(54) Title:** TIRE WITH TREAD WEAR INDICATORS**(57) Abstract**

The present invention relates to a tire (10) having a casing (12) with a carcass (14) and an annular tread (40) having lugs (44). The tread (10) may be divided into a plurality of circumferentially repeating design cycles of at least two design cycle lengths. At least some of the lugs (44) are inscribed or molded with indicia (42, 42a) for indicating the amount of lug wear. The indicia (42) is placed on a lug (44) in a position, usually a trailing side (54) of a lug (44), that is protected from wear, so that the indicia (42) is legible through out the useful life of the tire.



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## TIRE WITH TREAD WEAR INDICATORS

### Technical Field

5           The present invention relates to tires, and more specifically relates to tires having large and widely spaced traction lugs.

### Background Art

          With reference to agricultural tires, the drawbar traction characteristics of such tires are designed to optimize properties required for operating a tractor in a field. Traction against  
10   the soil is the main cause of lug wear.

          Tractor tires are often produced in an effort to provide operating characteristics for both on and off-the-road use. Such tires are described in U.S. Patent No. 3,603,370, issued to E. W. Hylbert et al. Road wear can be a contributing factor in lug wear.

          U.S. Patent, number 5,337,816, discloses an irrigation tire tread with each tread half  
15   having one long shoulder lug positioned between two pairs of short shoulder lugs.

          Off-the-road (OTR) tires used in, for example, mining or logging operations may also have large lugs, and a low net-to-gross ratio, and may be designed for traction in soil and rocks.

          In general, it has been found that although the useful life of the tire is dependent on the  
20   design and the use made of the tire, these types of tires are no longer efficient for their intended purpose when about two-thirds of the original lug height has been worn away. Because of the design of these types of tires, traditional tread wear indicators that are placed between lugs are not practical because of the wide spacing of lugs in the tire, and such tread indicators would wear away as fast as, or faster than the lugs. It is difficult, therefore, to get  
25   a quick and accurate indication of the lug wear in these types of tires.

          It is an object of the present invention to provide a tread wear indicator for low net-to-gross tires having large lugs that makes possible the estimation of lug wear by quick visual inspection.

          Other objects of the invention will be apparent from the following description and  
30   claims.

### Summary of the Invention

          The invention can be applied to a tire 10 having lugs 44. Each lug 44 has a land area 56, the land area 56 being bounded by a leading edge 52, and a trailing edge 54. The average distance between the leading and trailing edges substantially defines the radial outer lug width  
35   W. At least one of the lugs 44 has indicia 42, 42a, 42b, 42c on its trailing side 54, the indicia 42, 42a, 42b incrementally indicating the height of the lug.

The indicia 42,42a,42b,42c delineates at least 1/3 and 2/3 increments of the height of the at least one lug 44.

In one embodiment, the radially outermost 1/3 of the lug 44 has a width of  $W$ , the middle 1/3 of the lug 44 is delineated by a width of  $W+x$ , and the radially innermost 1/3 of the lug 44 is delineated by a width of  $W+x+y$ .

The indicia 42,42a,42b,42c may delineate the height of the at least one lug 44 in increments of one centimeter or less.

In a preferred embodiment, the indicia 42,42a,42b delineates only the useful portion of the lug 44.

In the illustrated embodiment, the tire 10 of the invention has a casing 12 with a carcass 14, and an annular tread 40 radially outwardly and integrally attached to the carcass 14. The tread 40 has a first set 48 and second set 50 of lugs 44. The first set 48 has a plurality of substantially parallel lugs 44 extending angularly from the first tread edge 30 toward the equatorial plane EP. The second set 50 has substantially parallel lugs 44 extending from the second tread edge 32 toward the equatorial plane EP. The second set 50 of lugs 44 are angularly inclined similar to but opposite in hand relative to the first set 48 of lugs 44.

#### DEFINITIONS

"Aspect Ratio" means the ratio of a tire's section height (SH) to its section width (SW).

"Axial" and "axially" means the lines or directions that are parallel to the axis of rotation of the tire.

"Bead" means that part of the tire comprising an annular tensile member wrapped by ply cords and shaped, with or without other reinforcement elements such as flippers, chippers, apexes, toe guards and chafers, to fit the design rim.

"Belt reinforcing structure" means at least two annular layers or plies of parallel cords, woven or unwoven, underlying the tread, unanchored to the bead, and having both left and right cord angles in the range from  $17^\circ$  to  $27^\circ$  with respect to the equatorial plane of the tire.

"Bias ply" means a tire having bias angled carcass, the angle of the cords being about  $25^\circ$  to  $50^\circ$  relative to the equatorial plane of the tire. Each adjacent ply has cords equal but oppositely oriented.

"Carcass" means the tire structure apart from the belt structure, tread, undertread, and sidewall rubber over the plies, but including the beads.

"Casing" means the tire structure apart from the tread and undertread, but including the sidewalls.

"Circumferential" means lines or directions extending along the perimeter of the surface of the annular tread perpendicular to the axial direction.

"Equatorial Plane (EP)" means the plane perpendicular to the tire's axis of rotation and passing through the center of its tread.

5 "Leading" refers to a portion or part of the tread that contacts the ground first, with respect to a series of such parts or portions, during rotation of the tire in the preferred direction.

"Net-to-gross ratio" means the ratio of the tire tread rubber that makes contact with a hard flat surface, divided by the area of the tread located between the lateral edges including  
10 non-contacting portions such as grooves as measured 360° circumferentially about the tire when the tire is inflated and under normal load conditions.

"Ply" means a continuous layer of rubber-coated parallel cords.

"Radial" and "radially" mean directions radially toward or away from the axis of rotation of the tire.

15 "Radial ply tire" means a belted or circumferentially-restricted pneumatic tire in which the ply cords which extend from bead to bead are laid at cord angles between 65° and 90° with respect to the equatorial plane of the tire.

#### **Brief Description of the Drawings**

Fig. 1 illustrates a perspective view of an agricultural tire 10 made in accordance with  
20 the present invention.

Fig. 2 illustrates a cross section of a tire of the invention.

Fig. 3 is an enlarged view of a lug of a tire.

Fig. 4 illustrates a side view of a lug of a tire with indicia.

Fig. 5 illustrates an alternative embodiment of a tread indicator of the invention.

25 Fig. 6 illustrates an end view of the lug of Fig. 5.

Fig. 7 illustrates a preferred embodiment of the tread indicator of the invention.

Fig. 8 illustrates a profile diagram of a lug having a tread indicator as illustrated in Fig. 7.

#### **Detailed Description of the Invention**

30 With particular reference now to Figs. 1-2, an illustrated tire of the invention is shown as an embodiment of a pneumatic agricultural tire 10.

Those skilled in the art will recognize that the invention may be used with any low net-to-gross tire with large lugs that is generally designed for off-the-road use.

The illustrated tire 10 has a nominal rim diameter of 32 inches (81 cm). The diameter

can be of any size suitable for agricultural use such as 16 to 58 inches (40.6 to 147.3 cm). The casing 12 includes a cord reinforced rubber-coated carcass 14 and a pair of beads 20, 20a. The carcass 14 as illustrated in Fig. 2 has two radial plies 15 extending from bead 20 to bead 20a and a belt reinforcement structure including four belt plies 13 radially outward of the carcass plies. The tire 10 has a tread 40 disposed radially outwardly of the casing 12. Any  
5 number of belt plies or carcass plies may be employed dependant on the service conditions required.

The illustrated tread 40 includes tread lugs 44.

The lugs 44 in the illustrated tire are divided into a first set 48 and a second set 50,  
10 each set extending from an opposite side of the tire 10. Each lug 44 has a leading side 52 and a trailing side 54 and a land area 56. Indicia 42 is stamped, molded or otherwise incorporated into or onto trailing side 54 of at least one lug 44. The second set 50 of lugs 44 are similar to but opposite in hand from the first set 48.

A tire according to the present invention can be designed with a variety of lug  
15 spacings.

The lugs may be of various shapes such as, but not limited to, straight, curved or multi-angled polygons. Furthermore, they can extend inwardly not crossing the equatorial plane, or can cross the equatorial plane.

The lugs may be pitched, as described in U.S. Patent 5,843,248, issued December 1,  
20 1998, which is incorporated herein by reference.

Indicia 42 may indicate wear level at which replacement of the tire is recommended, and may indicate the percentage of wear, so that in case of failure of a tire, the tread wear indicator can show directly the percentage of adjustment needed. In such an embodiment, it is preferred that the indicia have increments of one centimeter or less.

Those skilled in the art will recognize that the leading side 52 of a lug does most of the  
25 work in the tire, and together with land area 56 encounters most of the wear. The term "land area" refers to the radially outermost ground contacting part of the lug. Therefore, indicia 42 is placed on the trailing side 54 of a lug 44 to minimize wear on indicia 42 so that the numbers and lines on the indicia are legible throughout the useful life of the tire.

With reference now to Figs. 3 and 4, in one embodiment of the invention, indicia 42a  
30 is separated into three major portions showing demarcation of wear of 1/3 the lug height and 2/3 the lug height. Within the main areas of demarcation are additional, evenly spaced marks 43 that indicate 10% to 100% wear on the lug.

The percentage demarcation is useful for accumulating data regarding the wear of a tire

under specific conditions, and if such data is already available, determining whether a specific tire is wearing faster or slower than usual under such conditions.

It is desirable that at least one lug in the tire be marked with such indicia, and to protect against the possibility of unusual wear on the lug having the indicia, and to make it easier to find and read the lugs with the indicia while the tire is on a vehicle, it is preferred that at least three lugs carry such indicia.

With reference now to Figs. 5 and 6, in an alternative embodiment, indicia 42b may be stepped at the 1/3 and 2/3 demarcation lines so that if the trailing side 54 of a lug 44 encounters unusual wear, the increased thickness of the lug at the 1/3 remaining line can still be an indicator of when a tire is worn out.

Those skilled in the art will recognize that lugs 44 in these types of tires are buttressed so that they are wider at base 25 of the lug than they are at land area 56. In the stepped embodiment of Figs 5 and 6, W refers to the width of a lug 44 at the 2/3 available mark on the lug. The width x indicates the additional thickness marking the delineation of the top 1/3 of the lug and the middle 1/3 of the lug, and the width y indicates the thickness marking the delineation of the middle 1/3 of the lug and the bottom 1/3 of the lug. x and y may each represent a 0.01 cm to 0.05 cm step.

With reference now to Figs. 7 and 8, in a preferred embodiment, a treadwear indicator 42c may simply divide the usable portion of a lug 44 into suitable portions. In the illustrated embodiment, 00 indicate that the tire should be replaced, 25 indicates that 25% useful lug remains, 50 means 50% useful lug remains and 75 means 75% useful lug remains. The indicia are illustrated as protruding from the lug, but those skilled in the art will recognize that the indicia can be recessed, as shown in Fig. 4.

The 00 demarcation is located at the 1/3 available or remaining position on lug 44, since only the upper 2/3 of the lug provides efficient use of the tire. The upper 2/3 of the lug is divided into four equal portions using the three marks.

It is preferred that the treadwear indicators, in addition to being placed on the trailing side of a lug, be placed in a position on the trailing side of the lug which is least likely to encounter wear. The treadwear indicator 42c of Figs 7 and 8 is preferably placed in proximity to the end of adjacent lug 44, in protected position 45, as illustrated in Fig. 1. It is believed that the narrow distance between the end 47 of adjacent lug 44 and a treadwear indicator 42, 42a, 42b, 42c on lug 44 will prevent large, abrasive objects such as stones, from falling between the lugs and causing wear on the treadwear indicator. Those skilled in the art will be

able to find other protected areas on the trailing side of a lug 44 suitable for placement of a treadwear indicator.



## CLAIMS

1. A tire having a carcass (14), and an annular tread (40) radially outwardly and integrally attached to the carcass (14), said tread (40) having a low net-to-gross ratio and a set of large, substantially evenly spaced, and widely distributed lugs (44), the tire tread  
5 characterized by:
  - at least one of said lugs (44) having indicia (42,42a,42b,42c) on the trailing side (54) thereof, said indicia (42,42a,42b,42c) incrementally indicating the height of said lug.
2. The tire of claim 1 wherein said indicia (42,42a,42b,42c) delineates at least 1/3 and 2/3 increments of the height of said at least one lug (44).
- 10 3. The tire of claim 2 wherein the radially outermost 1/3 of said lug (44) has a width of W, the middle 1/3 of said lug (44) is delineated by a width of  $W+x$ , and the radially innermost 1/3 of said lug (44) is delineated by a width of  $W+x+y$ .
4. The tire of claim 1 wherein said indicia (42,42a,42b,42c) delineates the height of said at least one lug (44) in increments of one centimeter or less.
- 15 5. The tire of claim 1 wherein indicia (42,42a,42b,42c) delineates only the useful portion of said lug (44).
6. The tire of claim 1 wherein indicia (42,42a,42b,42c) is located in a protected position (45) on a trailing side (54) of a lug (44).

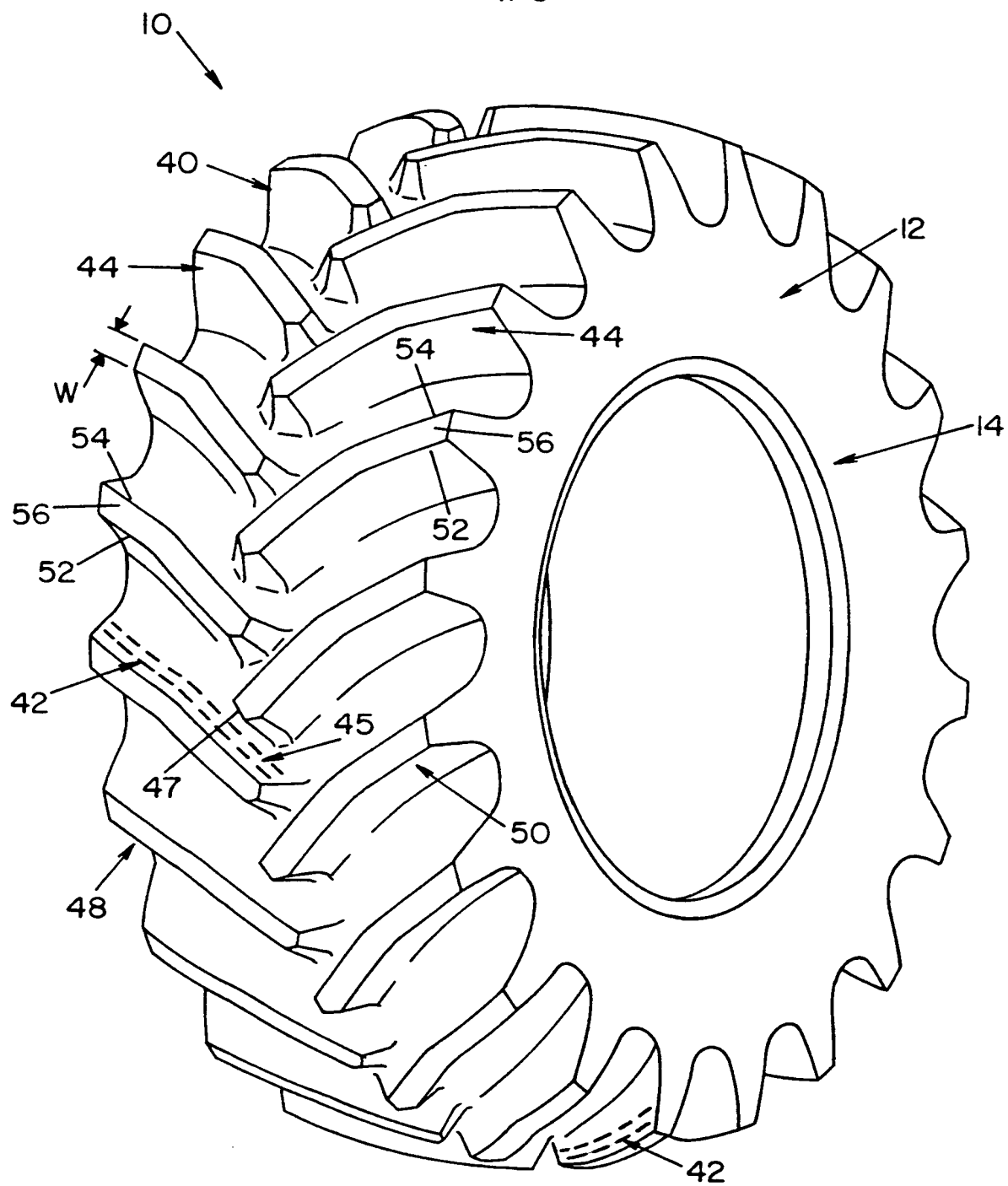


FIG. 1

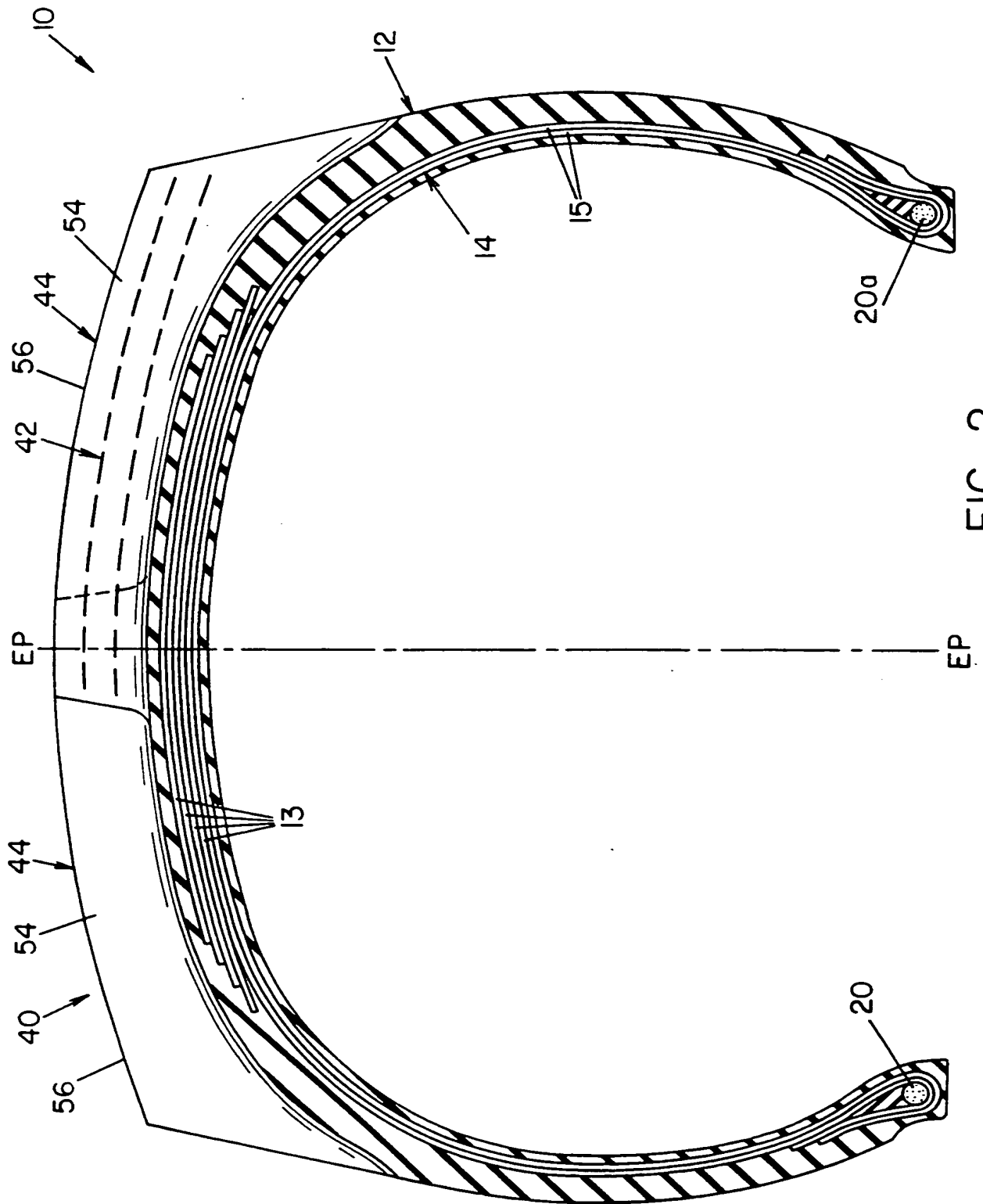
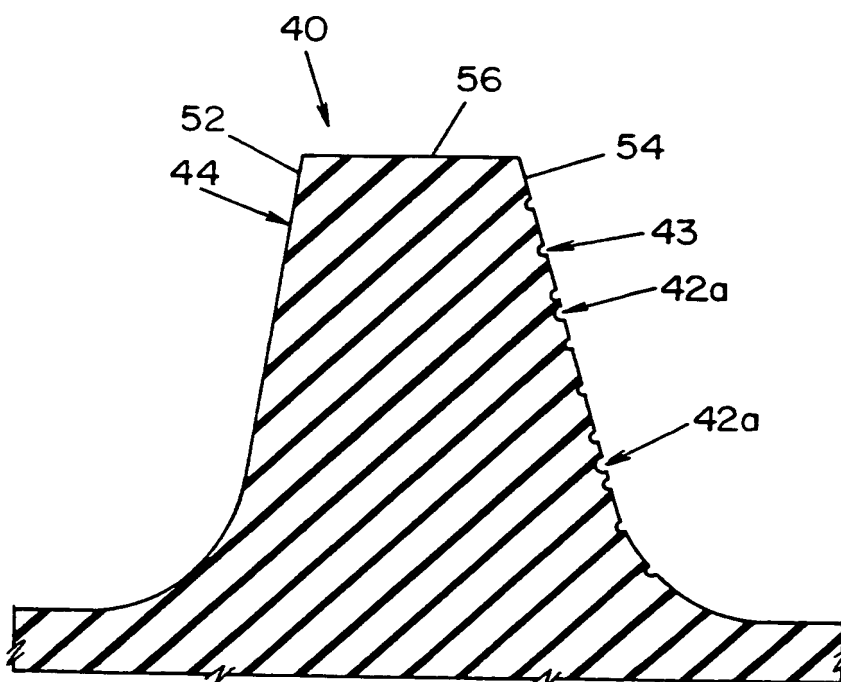
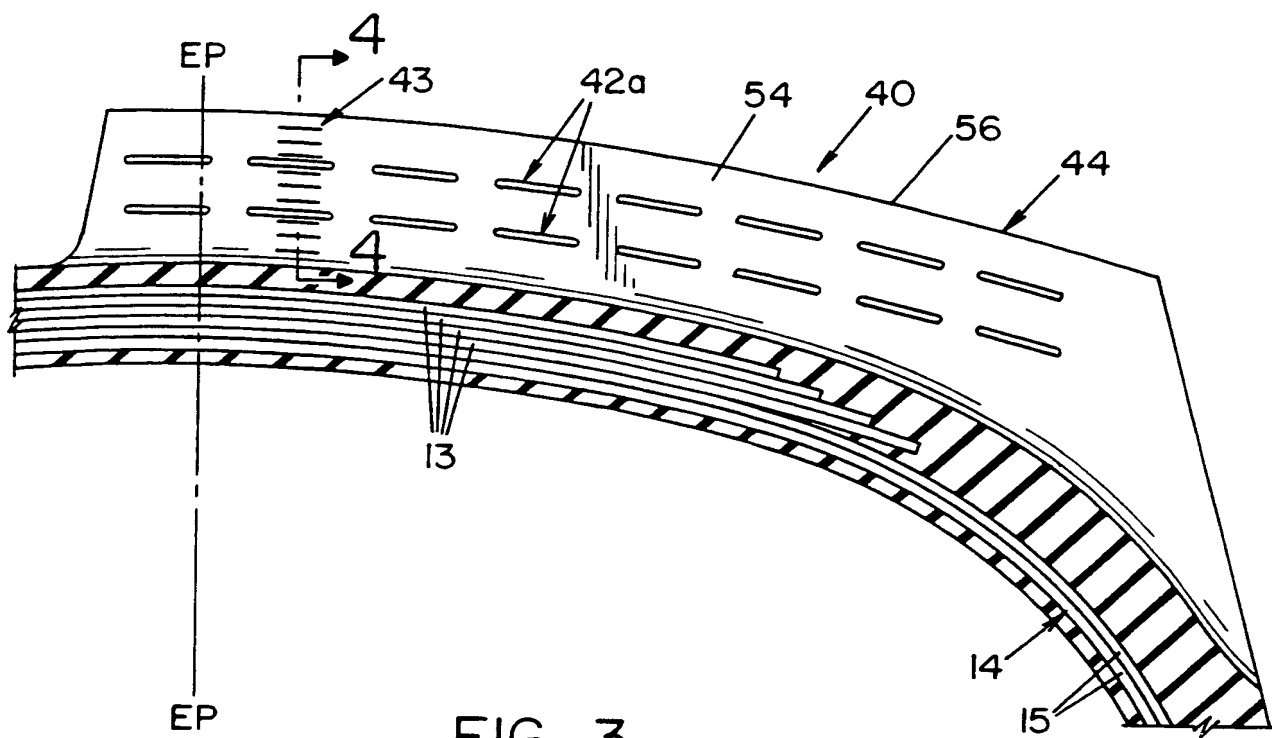


FIG. 2

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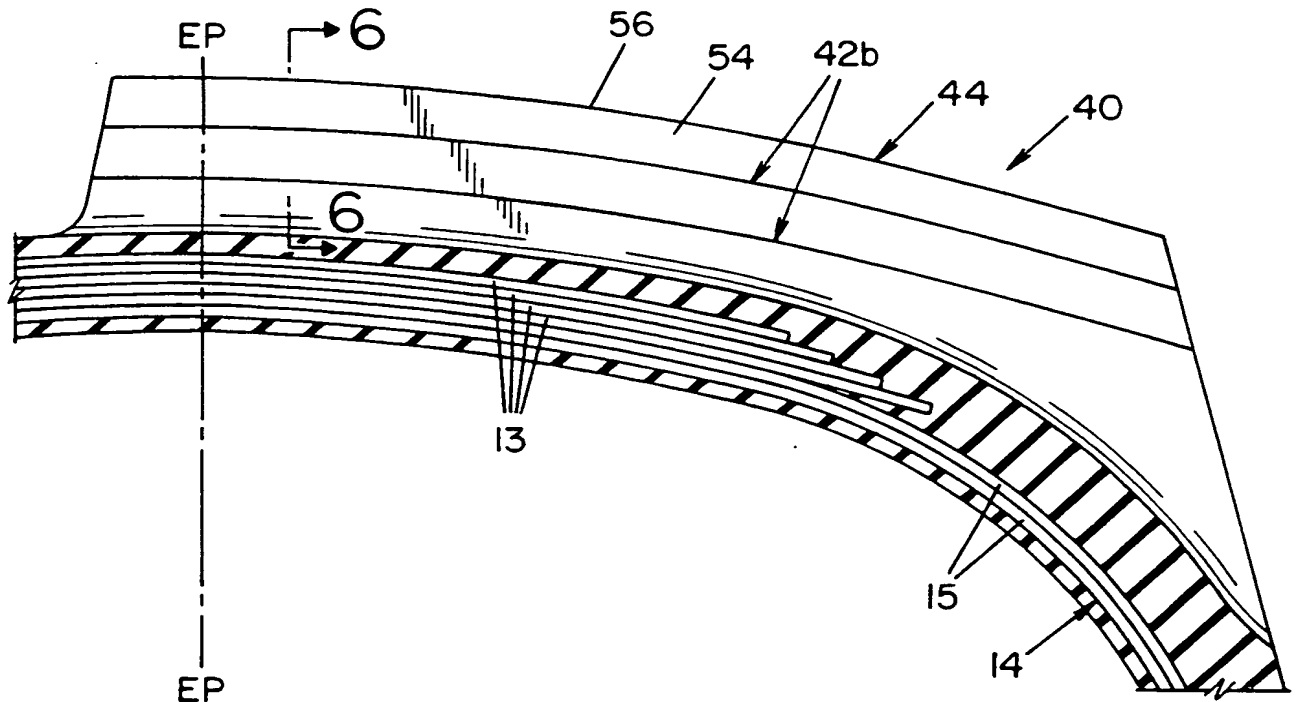


FIG. 5

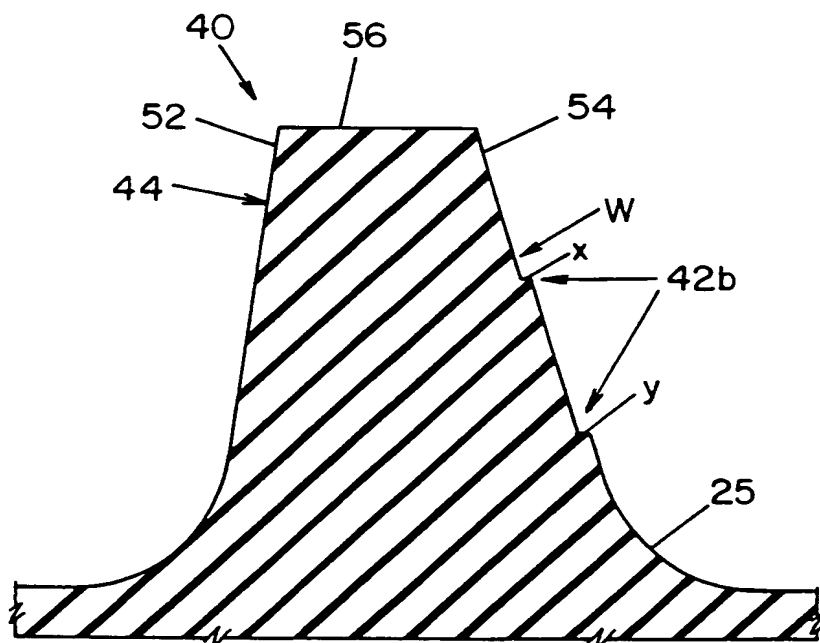


FIG. 6

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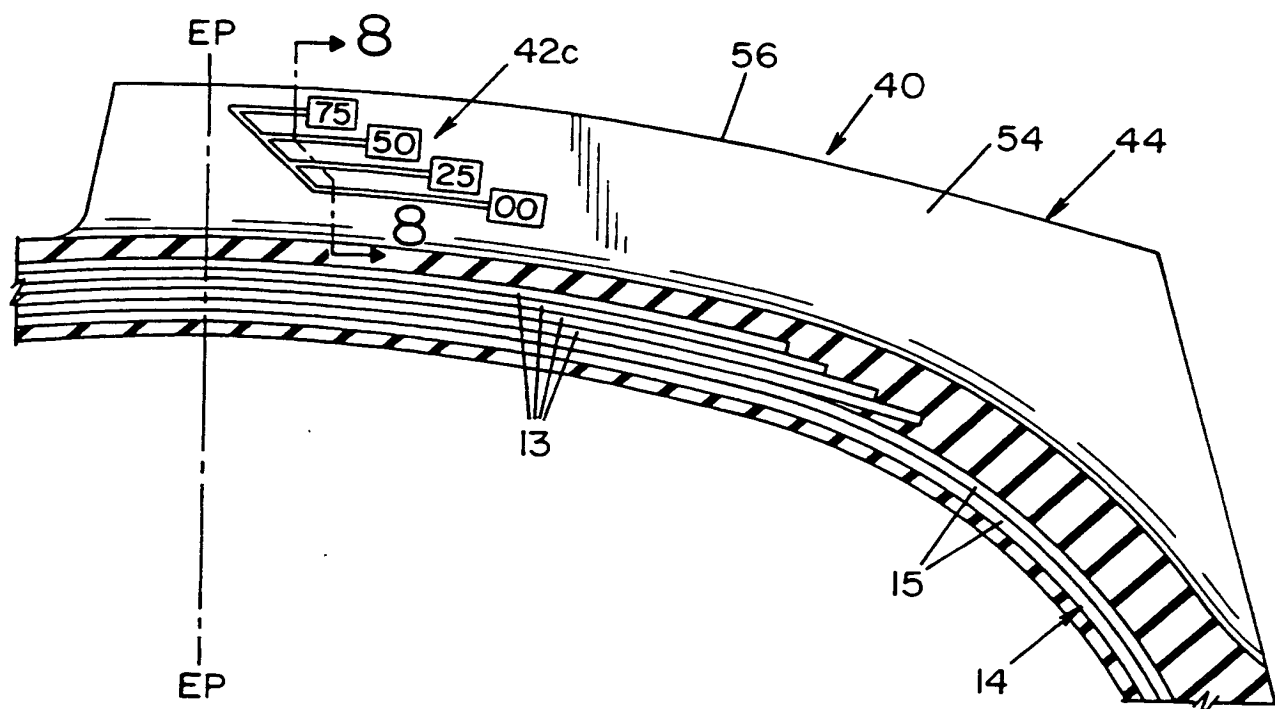


FIG. 7

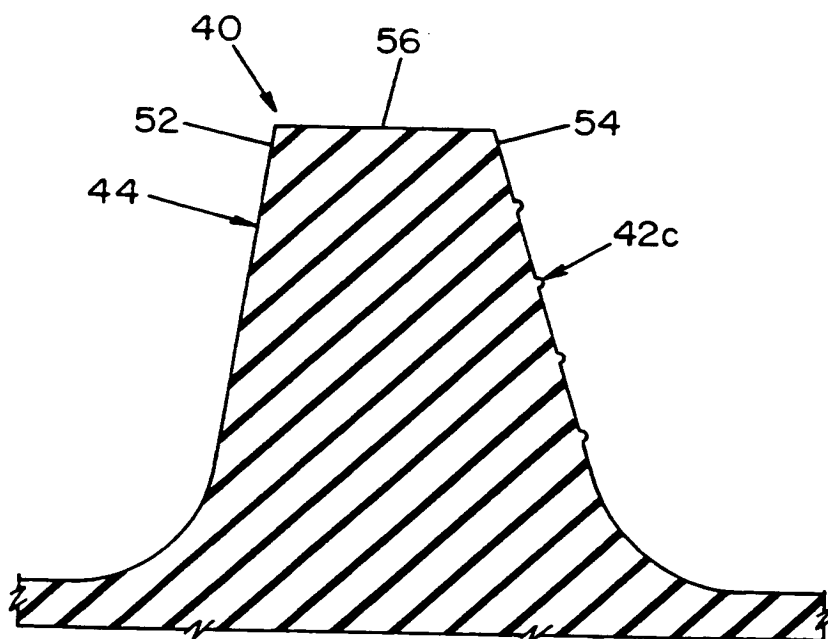


FIG. 8

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 99/09394

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B60C11/24 B60C11/04 //B60C107:02

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Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B60C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2 706 509 A (E.J. WHITE) 19 April 1955 (1955-04-19) page 1, line 61 - line 80; claims: figures ---	1
A	US 5 337 816 A (BONKO MARK L ET AL) 16 August 1994 (1994-08-16) cited in the application claim 1 -----	1

☐ Further documents are listed in the continuation of box C.



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Date of mailing of the international search report

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Information on patent family members

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